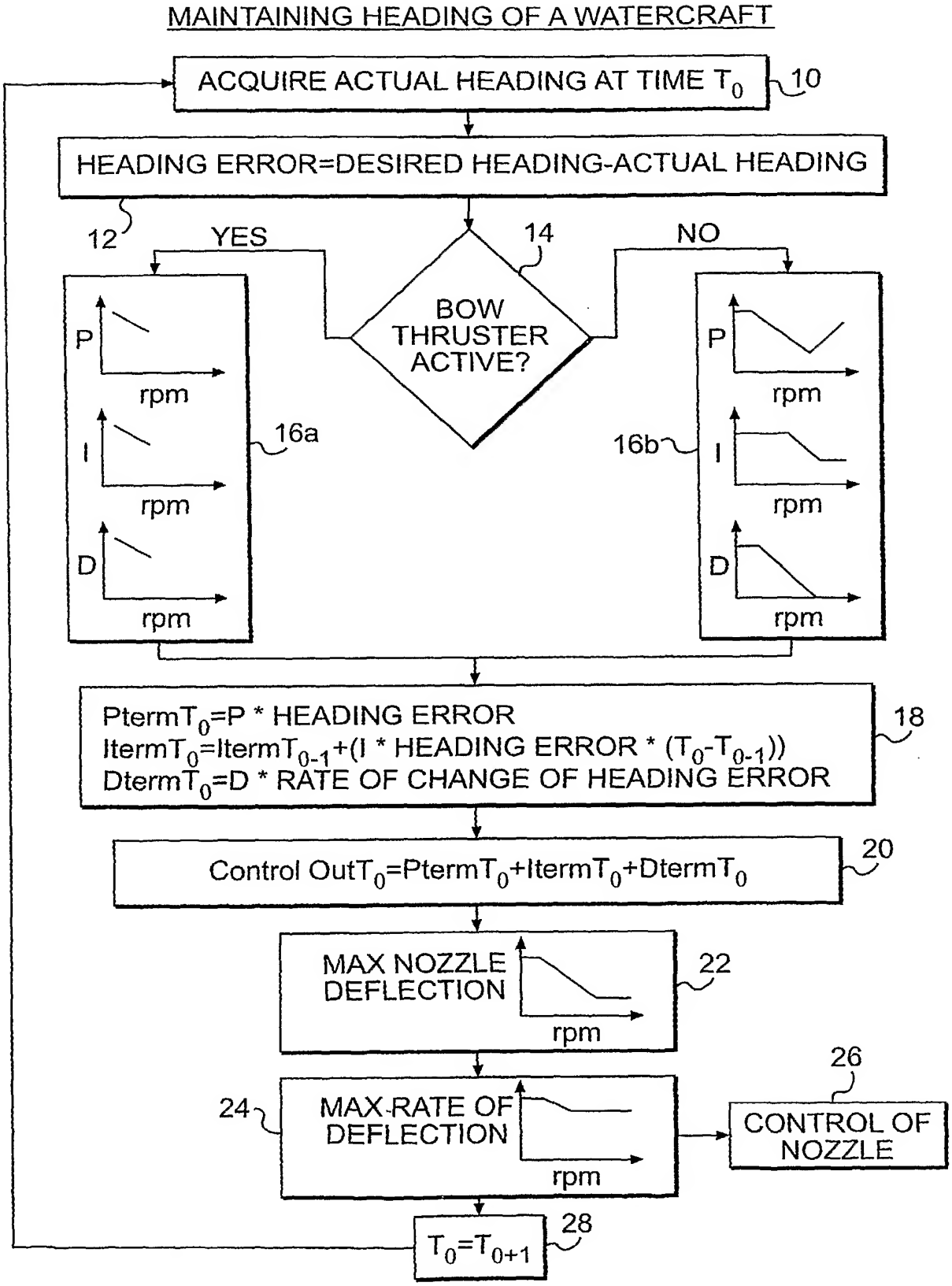
MAINTAINING HEADING OF A WATERCRAFT
ACQUIRE ACTUAL HEADING AT TIME T_0
10
HEADING ERROR=DESIRED HEADING-ACTUAL HEADING
12
YES
14
NO
BOW THRUSTER ACTIVE?
P
rpm
I
rpm
D
rpm
16a
16b
$PtermT_0$=P * HEADING ERROR
$ItermT_0$=$ItermT_{0-1}$+(I * HEADING ERROR * (T_0-T_{0-1}))
$DtermT_0$=D * RATE OF CHANGE OF HEADING ERROR
18
Control $OutT_0$=$PtermT_0$+$ItermT_0$+$DtermT_0$
20
MAX NOZZLE DEFLECTION
22
MAX-RATE OF DEFLECTION
24
CONTROL OF NOZZLE
26
T_0=T_{0+1}
28

FIG. 1

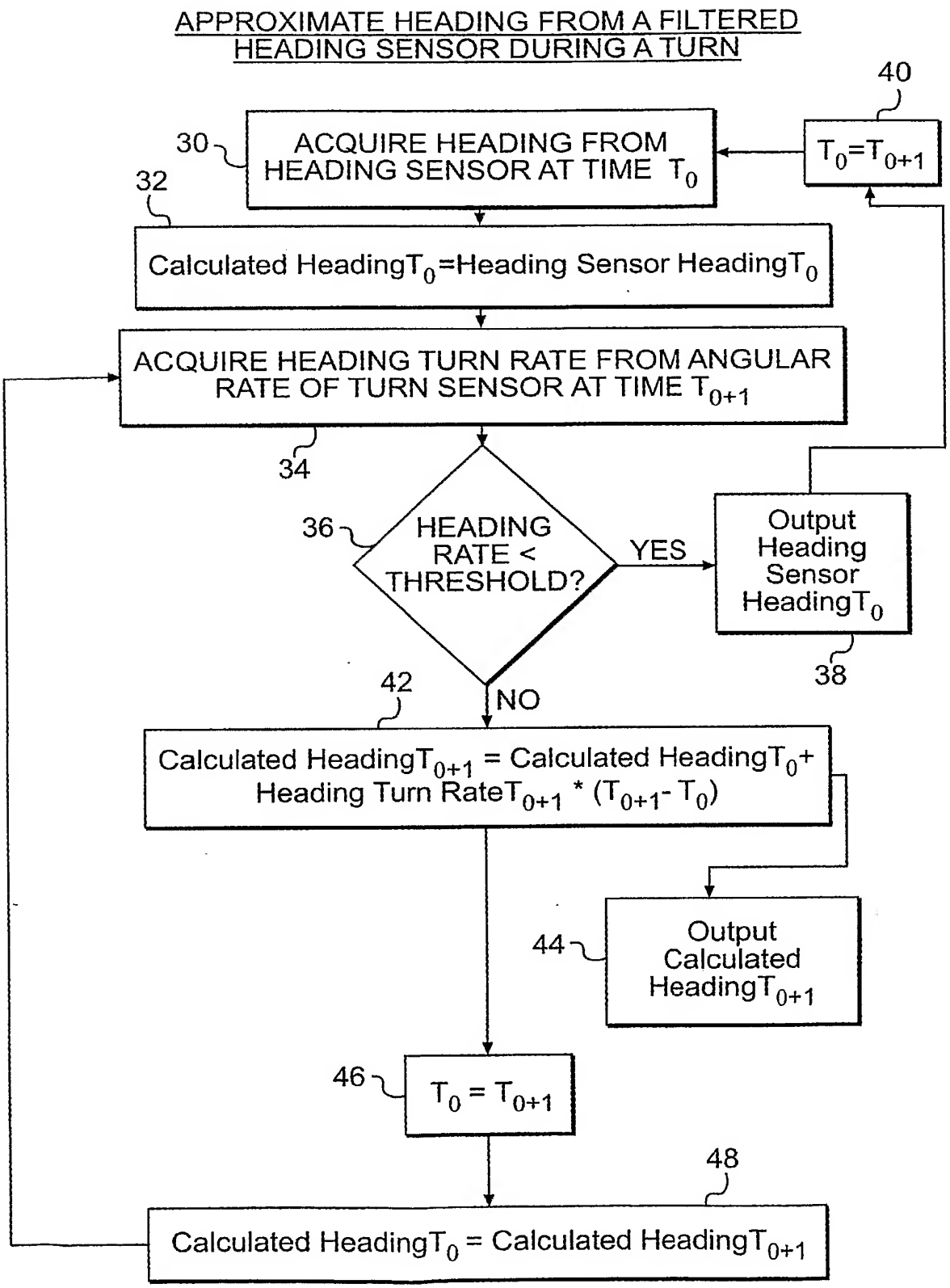
APPROXIMATE HEADING FROM A FILTERED HEADING SENSOR DURING A TURN
40
30
ACQUIRE HEADING FROM HEADING SENSOR AT TIME T_0
$T_0=T_{0+1}$
32
Calculated HeadingT_0=Heading Sensor HeadingT_0
ACQUIRE HEADING TURN RATE FROM ANGULAR RATE OF TURN SENSOR AT TIME T_{0+1}
34
36
HEADING RATE < THRESHOLD?
YES
Output Heading Sensor HeadingT_0
38
NO
42
Calculated HeadingT_{0+1} = Calculated HeadingT_0+ Heading Turn RateT_{0+1} * (T_{0+1}- T_0)
44
Output Calculated HeadingT_{0+1}
46
$T_0 = T_{0+1}$
48
Calculated HeadingT_0 = Calculated HeadingT_{0+1}

FIG. 2

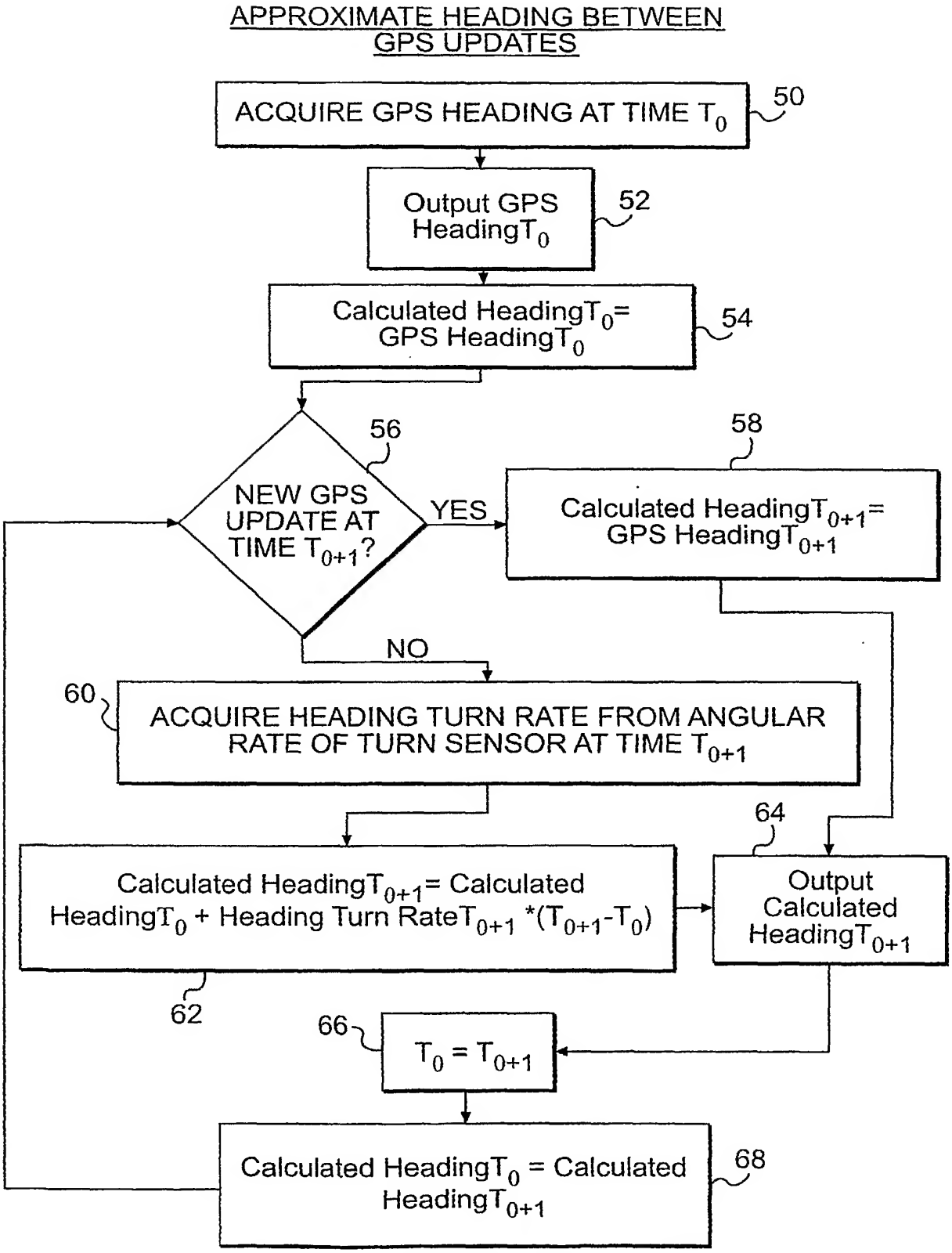
APPROXIMATE HEADING BETWEEN GPS UPDATES
ACQUIRE GPS HEADING AT TIME T_0
50
Output GPS HeadingT_0
52
Calculated HeadingT_0= GPS HeadingT_0
54
56
NEW GPS UPDATE AT TIME T_{0+1}?
YES
58
Calculated HeadingT_{0+1}= GPS HeadingT_{0+1}
NO
60
ACQUIRE HEADING TURN RATE FROM ANGULAR RATE OF TURN SENSOR AT TIME T_{0+1}
64
Calculated HeadingT_{0+1}= Calculated HeadingT_0 + Heading Turn RateT_{0+1} *(T_{0+1}-T_0)
Output Calculated HeadingT_{0+1}
62
66
T_0 = T_{0+1}
Calculated HeadingT_0 = Calculated HeadingT_{0+1}
68

FIG. 3

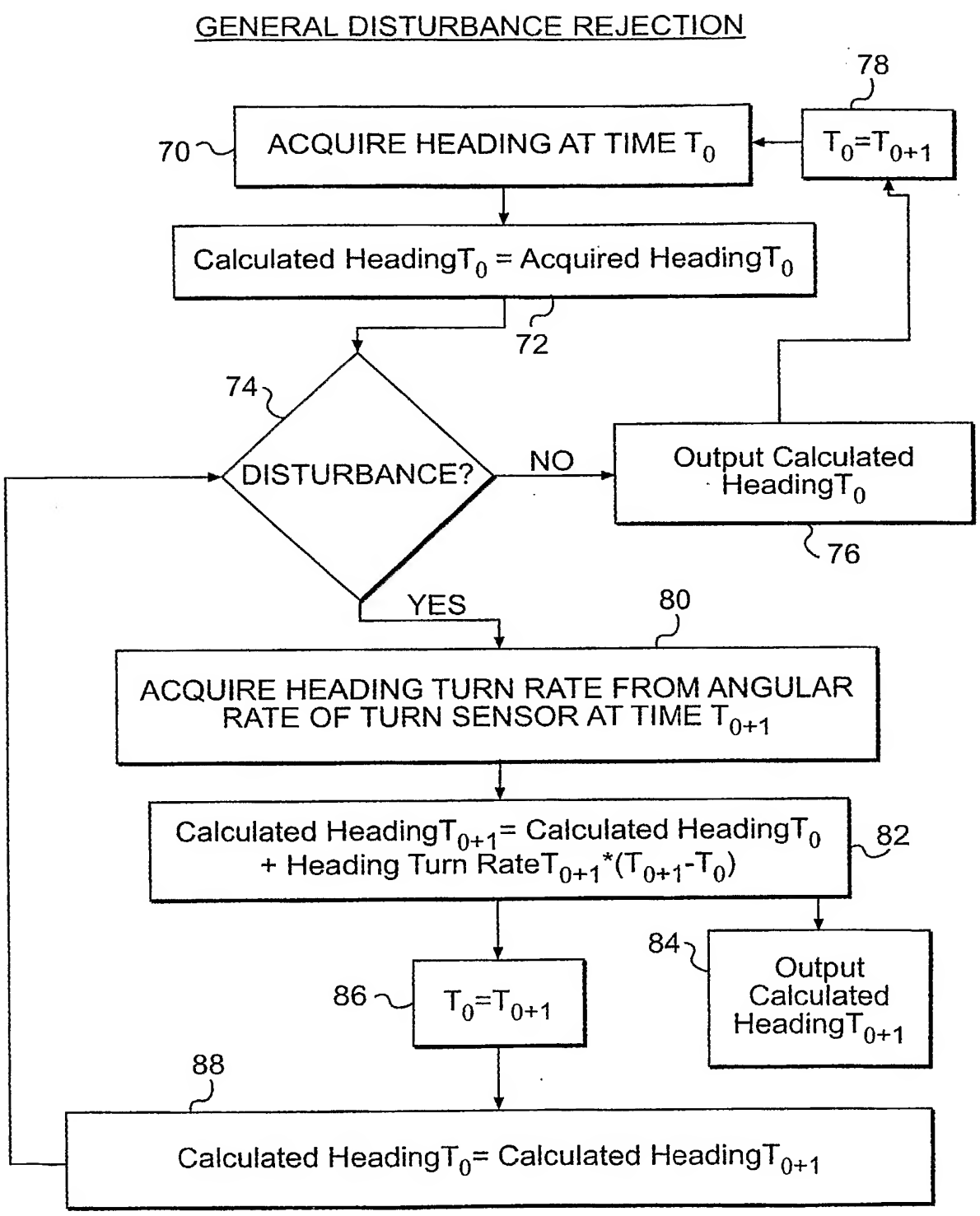
GENERAL DISTURBANCE REJECTION
78
70
ACQUIRE HEADING AT TIME T_0
$T_0=T_{0+1}$
Calculated HeadingT_0 = Acquired HeadingT_0
72
74
DISTURBANCE?
NO
Output Calculated HeadingT_0
76
YES
80
ACQUIRE HEADING TURN RATE FROM ANGULAR RATE OF TURN SENSOR AT TIME T_{0+1}
Calculated HeadingT_{0+1}= Calculated HeadingT_0 + Heading Turn RateT_{0+1}*(T_{0+1}-T_0)
82
84
Output Calculated HeadingT_{0+1}
86
$T_0=T_{0+1}$
88
Calculated HeadingT_0= Calculated HeadingT_{0+1}

FIG. 4

DISTURBANCE REJECTION

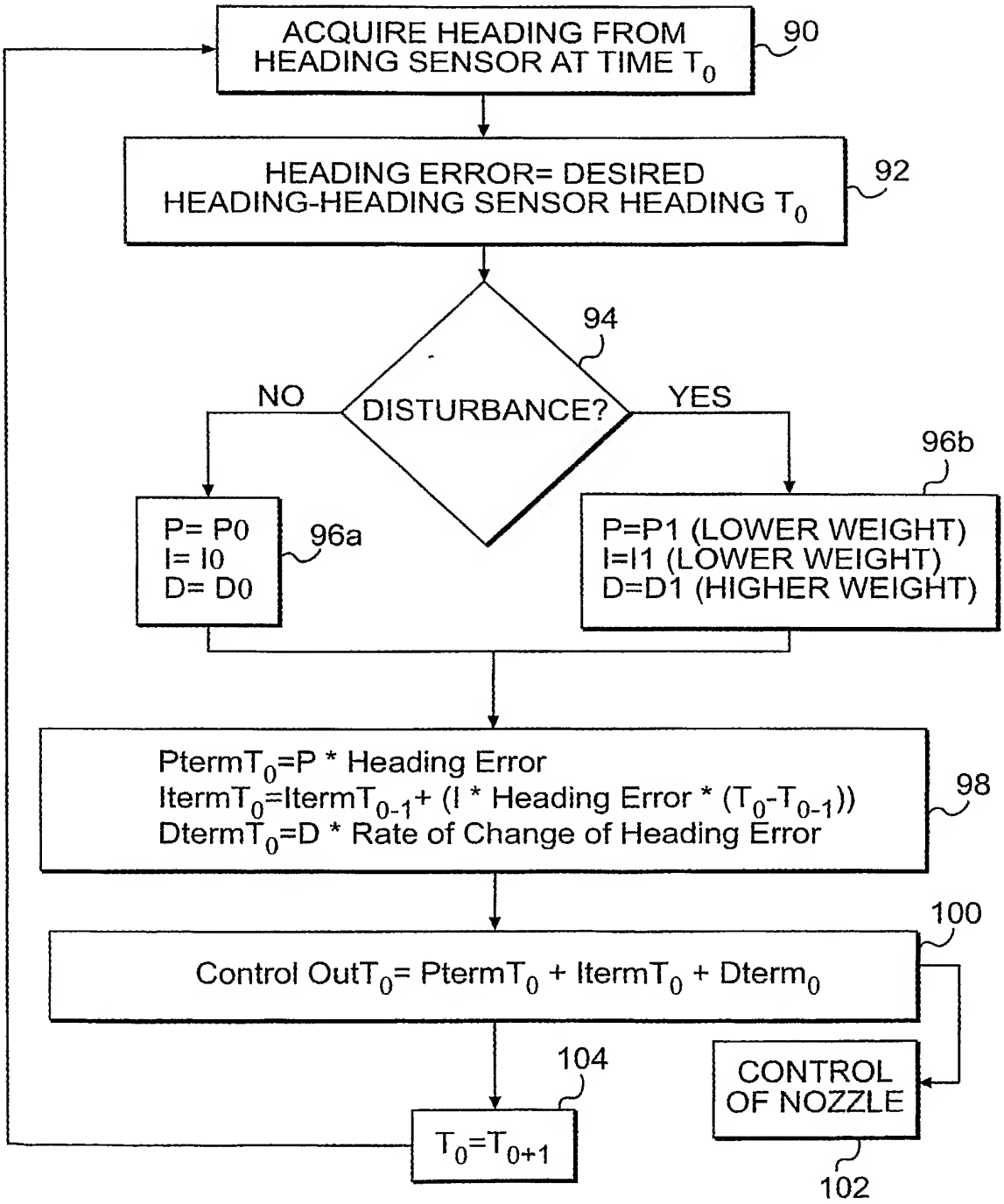

FIG. 5

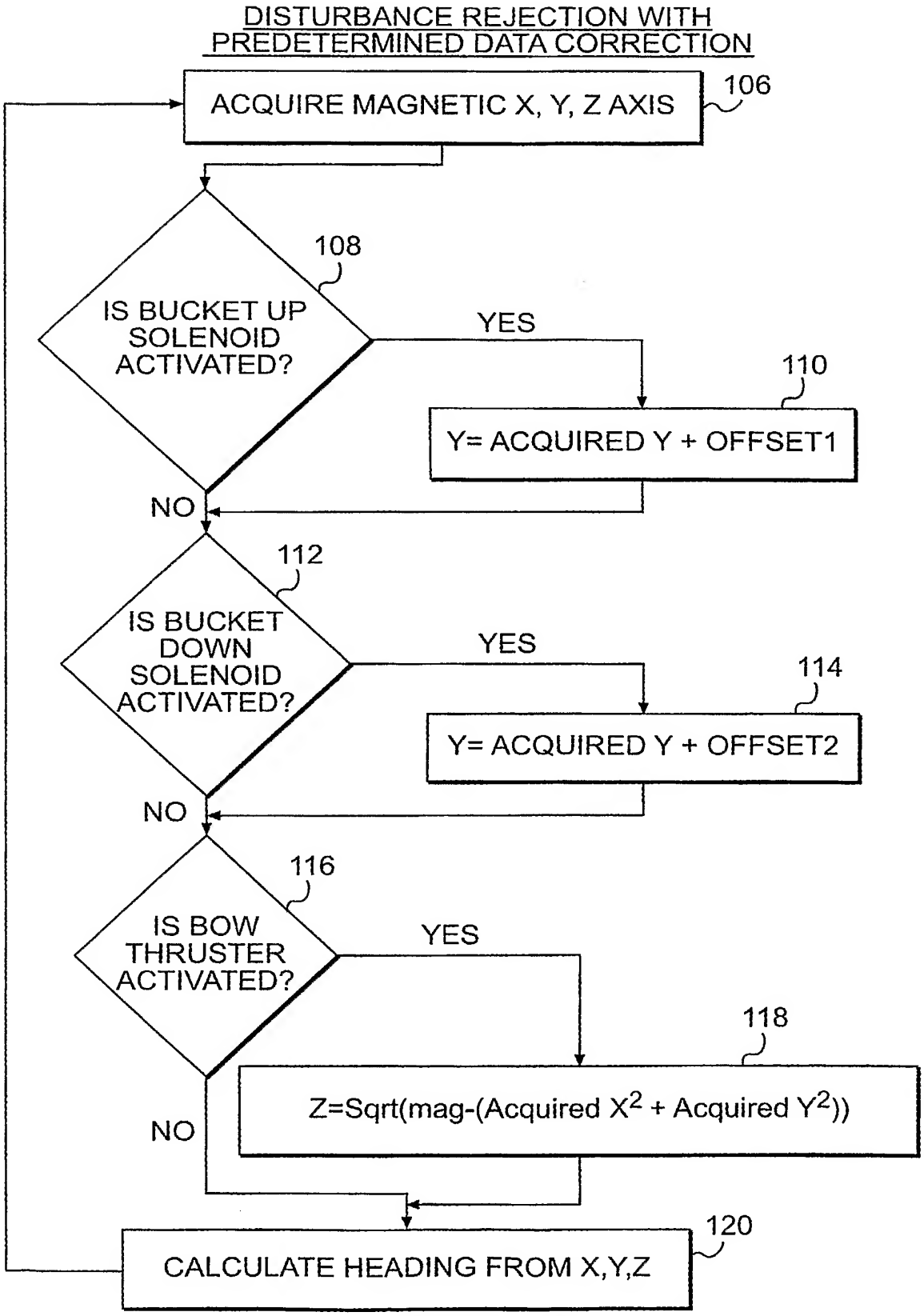
DISTURBANCE REJECTION WITH PREDETERMINED DATA CORRECTION
ACQUIRE MAGNETIC X, Y, Z AXIS
106
IS BUCKET UP SOLENOID ACTIVATED?
108
YES
110
Y= ACQUIRED Y + OFFSET1
NO
IS BUCKET DOWN SOLENOID ACTIVATED?
112
YES
114
Y= ACQUIRED Y + OFFSET2
NO
IS BOW THRUSTER ACTIVATED?
116
YES
118
Z=Sqrt(mag-(Acquired X2 + Acquired Y2))
NO
CALCULATE HEADING FROM X,Y,Z
120

FIG. 6

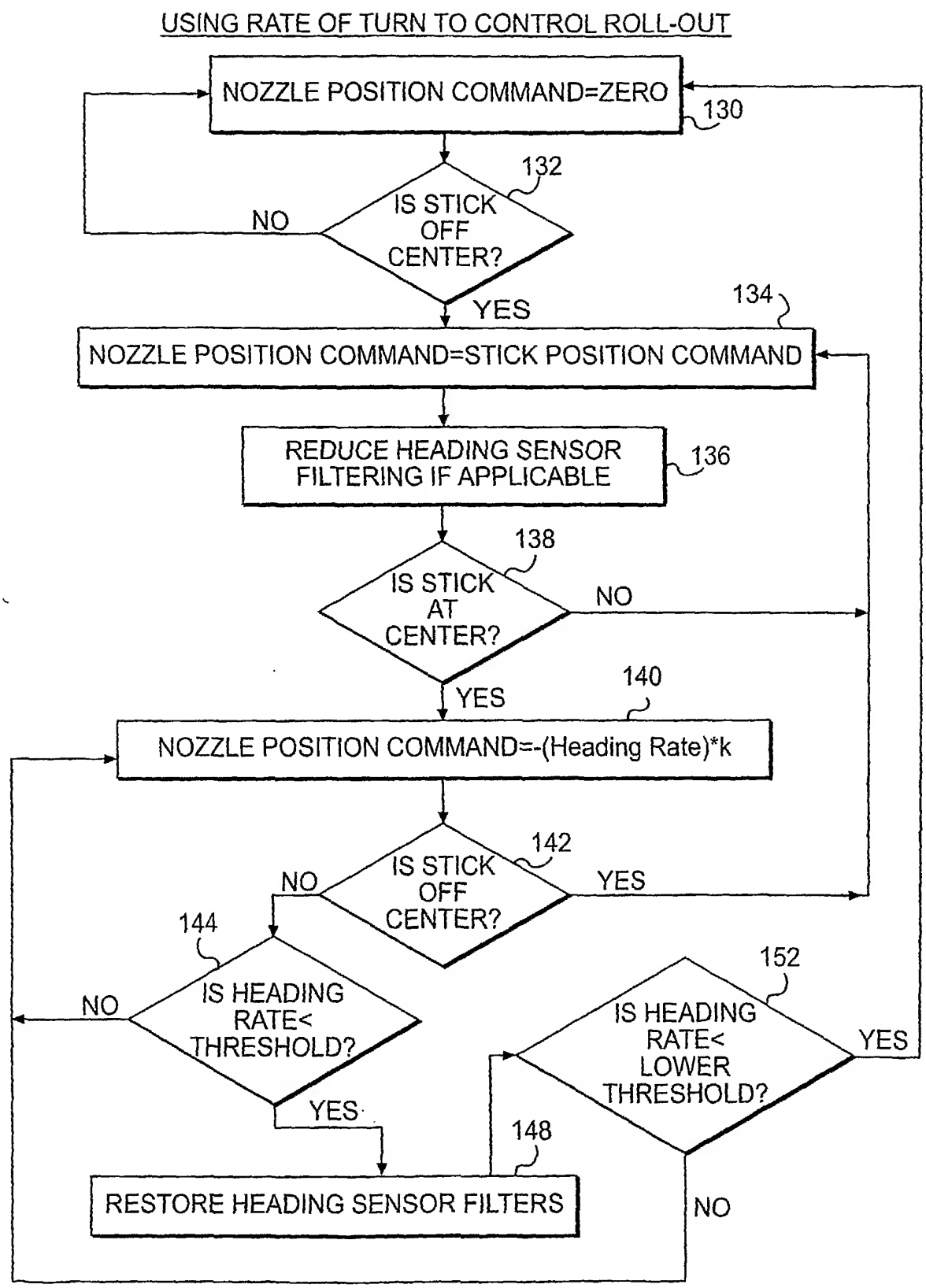
USING RATE OF TURN TO CONTROL ROLL-OUT
NOZZLE POSITION COMMAND=ZERO
130
132
IS STICK OFF CENTER?
NO
YES
134
NOZZLE POSITION COMMAND=STICK POSITION COMMAND
REDUCE HEADING SENSOR FILTERING IF APPLICABLE
136
138
IS STICK AT CENTER?
NO
YES
140
NOZZLE POSITION COMMAND=-(Heading Rate)*k
142
IS STICK OFF CENTER?
NO
YES
144
IS HEADING RATE< THRESHOLD?
NO
YES
152
IS HEADING RATE< LOWER THRESHOLD?
YES
NO
148
RESTORE HEADING SENSOR FILTERS

FIG. 7